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(54) **MEMBRANE BASED FUEL
DEOXYGENATOR**

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96/11

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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,268,279	*	5/1981	Shindo et al.	95/46
4,539,113	*	9/1985	Tomita et al.	96/6 X
4,729,773	*	3/1988	Shirato et al.	96/6
4,740,219	*	4/1988	Kulprathipanja et al.	95/54 X
4,869,732	*	9/1989	Kalfoglou	95/46
5,078,755	*	1/1992	Tozawa et al.	95/46
5,695,545	*	12/1997	Cho et al.	95/46
5,723,035	*	3/1998	Mazanec et al.	96/6 X
5,762,684	*	6/1998	Hayashi et al.	95/46 X
5,830,261	*	11/1998	Hamasaki et al.	95/46 X
5,888,275	*	3/1999	Hamasaki et al.	95/46 X
5,968,366	*	10/1999	Deckman et al.	95/45 X
6,168,648	*	1/2001	Ootani et al.	95/46

FOREIGN PATENT DOCUMENTS

4006465A	*	9/1991	(DE)	96/6
0385947A	*	9/1990	(EP)	95/45
03-213103A	*	9/1991	(JP)	95/46
04-290502A	*	10/1992	(JP)	95/46
04-349902A	*	12/1992	(JP)	95/46
0668875A	*	6/1979	(RU)	96/6
1646572A	*	5/1991	(RU)	96/6

OTHER PUBLICATIONS

S. Darah, "Jet Fuel Deoxygenation", Geo Centers, Inc., (Oct. 1988), Interim Report under Contract AFWAL-TR-88-2081, 28 pages.

J.D. Seader et al., "Separation Process Principles", John Wiley & Sons, Inc., (Dec. 1997), pp. 720-726.

* cited by examiner

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(57) **ABSTRACT**

Apparatus and method for the deoxygenation of liquid fuel in the fuel system of an energy conversion device, such as an aircraft gas turbine engine. A membrane filter is disposed in the fuel system and is selected to remove oxygen from the fuel, typically a hydrocarbon, while excluding the fuel. The membrane filter may be permeable or porous to the oxygen and, in a preferred embodiment, is of polytetrafluoroethylene. Fuel with dissolved oxygen (typically from air) is flowed in contact with one surface of the membrane filter, and removed oxygen is collected from the opposite surface of the filter. The difference in the partial pressure of oxygen across the membrane filter may be controlled to regulate the driving force for moving oxygen through the membrane. Reduction of the oxygen concentration in jet fuel to less than 10 ppm at liquid space velocities of 100/hr and greater are attained.

22 Claims, 8 Drawing Sheets

